Synthesis and chemical nature of the products of Co(II) and Mg phosphates coprecipitation

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The work carried out in terms of diversification of hydrated phosphates that contain two different cations in their composition the contents of which can be purposely changed. Thereby their physico-chemical and exploitation properties could be changed in the wide limits.

The aim of this work was to determine the composition and chemical nature of the products of cobalt(II) and magnesium phosphate coprecipitation.

The joint precipitation of Co^{2+} and Mg^{2+} cations was carried out under conditions that provide the formation of the secondary hydrated phosphates. Specific conditions of precipitation were chosen for separate series of experiments depending on the composition of the solid phase from the main process parameters. pH of the reaction solutions was changed using aqueous solutions of Na_2HPO_4, Na_3PO_4 or their mixture Na_2HPO_4 : Na_3PO_4 = 2 : 1 and Na_2HPO_4 : Na_3PO_4 = 1:1 as precipitator. Correlation in the initial solutions $n = P/\sum Co^{2+}$, Mg^{2+} was maintained equal to 0.67 that was stoichiometric and it was necessary for the formation of secondary phosphates of divalent metals. Correlation of cations $K = Co^{2+}/Mg^{2+}$ was varied within the range from 25.0 to 1.5. Concentration of the solutions was changed in the range of 0.05–0.25 mol/l, the deposition temperature was maintained in the range of 50–75 °C.

The results of complex analyzes of the solid phase showed that at the values $K = Co^{2+}/Mg^{2+}$=25.0–1.6 octahydrate secondary phosphates were formed. They contained both Co^{2+} and Mg^{2+} cations. The ratio of cations could be changed within wide limits by the variation of composition of the initial reagents (Table). The general formula of precipitated phosphates was $Co_{3-x}Mg_x(PO_4)_2 \cdot 8H_2O$. The synthesized phosphates presented themselves solid solution of substitution. The region of homogeneity at the use of Na_2HPO_4 : Na_3PO_4 = 1 : 1 as a precipitator was maximal and could be varied in the limits $0 < x \leq 1.00$. The saturated solid solution what formed under these conditions which had the composition of $Co_{2.0}Mg_{1.0}(PO_4)_2 \cdot 8H_2O$.

Table – The dependence of $Co_{3-x}Mg_x(PO_4)_2 \cdot 8H_2O$ ($0 < x \leq 1.00$) phosphates composition on the ratio K = Co/Mg in the initial solutions (precipitator was Na_2HPO_4 : Na_3PO_4 = 1 : 1)

Correlation K = Co/Mg, mol	The composition of the solid phase				
	Chemical, wt. %				Phase
	Co	Mg	P	H_2O	
25.0	41.77	0.54	13.62	15.86	$Co_{2,9}Mg_{0,1}(PO_4)_2 \cdot 8H_2O$
9.0	40.15	1.35	13.50	15.92	$Co_{2.75}Mg_{0.25}(PO_4)_2 \cdot 8H_2O$
4.0	37.48	2.74	14.22	16.23	$Co_{2.51}Mg_{0.49}(PO_4)_2 \cdot 8H_2O$
2.5	34.70	4.13	14.31	16.63	$Co_{2.27}Mg_{0.73}(PO_4)_2 \cdot 8H_2O$
1.6	31.36	5.83	14.87	17.26	$Co_{2.0}Mg_{1.0}(PO_4)_2 \cdot 8H_2O$
1.5	28.49	8.36	15.79	17.02	The mechanical mixture of two phases: $Co_{2.0}Mg(PO_4)_2 \cdot 8H_2O + MgHPO_4 \cdot 3H_2O$

If an aqueous Na_2HPO solution was used as a precipitator the range of homogeneity of $Co_{3-x}Mg_x(PO_4)_2 \cdot 8H_2O$ solid solution was $0 < x \leq 0.54$ or at Na_2HPO_4 : Na_3PO_4 = 2 : 1 it was varied in the limits of $0 < x \leq 0.70$. Trying to obtain octahydrate Co(II)–Mg phosphate with magnesium content larger than 5.83 wt. % ($K = Co^{2+}/Mg^{2+} < 1.6$) the precipitation of mechanical mixture of two crystalline phases occurred.